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By-Wakefield, Howard E.

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Three topics are discussed--(1) designing the environment of educational enterprises, (2) capabilities and promise of data processing in comprehending the educational environment, and (3) optimum learning environments - design mechanisms, principles, and application. Consultants for the first topic were Sydney H. Williams, who surveyed the state of art in planning, Max E. Anderson, who discussed problems of educational planning, and Kenton Peters, who concluded with the architect's view of school planning. Participants in the second topic of discussion were Dr. Charles Trotter, specialist in the United States Office of Education's Office of Construction Services and Dr. E. Gordon Richardson, staff member at the Iowa Education Information Center. Consultants for the third topic were Professor Byron C. Bloomfield, Director of the Environmental Design Center, University of Wisconsin, who outlined its origin and purpose and Dr. Darell Boyd Harmon, Research Professor at the Environmental Design Center, who discussed the physical problems of educational environments and suggested improvements. (RH)

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service through research

Designing An Environment For Learning

Designing An Environment For Learning

Proceedings of A
Conference of Educational Survey
Directors of Member Universities
of the
Committee on Institutional Cooperation

April 27-28, 1967
Madison, Wisconsin

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Foreword

To the best of my recollection, the survey directors of C.I.C. institutions held their first meeting at Indiana University in 1959. We have met every year since then, except for 1964, when we shifted from a fall meeting in 1963 to a spring meeting in 1965. We have now met at the following institutions on the general topics or themes indicated:

Indiana	1959 - Private survey organizations and consultants
Illinois	1960 - Standards for Educational Consultants
Purdue	1961 - Inter- and Intra University Relationships
Mich. St.	1962 - Evaluating Surveys
Ohio	1963 - Frontier Perspectives
Chicago	1965 - The Chicago Surveys
Mich.	1966 - The Community College Survey
Wis.	1967 - Evnironmental Aspects

The proceedings of this meeting at Wisconsin were prepared from notes taken by me. Judith Wilson assisted in this process.

Howard E. Wakefield

Conference of
Survey Directors of the C. I. C. Universities

Wisconsin Center
Langdon and Lake Streets
Madison, Wisconsin

April 27-28, 1967

FIRST SESSION - 1:00 p.m. — Room 311, Wisconsin Center

Topic: "Designing the Environment of Educational Enterprises"

Consultants:
Sydney H. Williams, Visiting Mellon Lecturer
Department of Urban and Regional Planning
The University of Wisconsin

Max E. Anderson, Planning Consultant
Max E. Anderson Associates, Madison

Kenton A. Peters, A. I. A.
Partner, Peters & Martinsons Associates, Madison

Chairman: Howard E. Wakefield, Director
Cooperative Educational Research & Services
The University of Wisconsin

Dinner - 6:30 p.m. — Madison Inn

SECOND SESSION - 7:30 p.m. — Madison Inn

Topic: "Capabilities and Promise of Data Processing in Comprehending the Educational Environment"

Speaker: E. Gordon Richardson, Coordinator
Research & Specifications Development
Iowa Educational Information Center
The University of Iowa

Chairman: Harvin Fruth, Assistant Director
Wisconsin Information Systems in Education
The University of Wisconsin

THIRD SESSION - 9:00 a.m. — Room 311, Wisconsin Center

Topic: "Optimun Learning Environments - Design Mechanisms, Principles, and Applications"

Consultants:
Byron Bloomfield, A.I. A.
Director, Environmental Design Center
The University of Wisconsin

Darell Boyd Harmon, Visiting Research Professor
Environmental Design Center
The University of Wisconsin

Chairman: Howard E. Wakefield

Conference of
Survey Directors of the C. I. C. Universities

The University of Wisconsin, Madison
April 27-28, 1967

ROSTER OF REGISTRANTS

Name	Position	Institution
Montfort Barr	Assistant Director of School Surveys Surveys School of Education	Indiana University
George Beauchamp	Chairman, Committee on School Service	Northwestern University
John Butler	Office of Public Relations	Edgewood College
William Clements	Director of Institutional Research and Studies	Wis. State University Stevens Point
Marion Conrad	Head, Educational Administration and Facilities Unit, School of Education	Ohio State University
Marvin Fruth	Assistant Director, Wisconsin Information Systems in Education	The University of Wisconsin
William Griffith	Educational Administration and Facilities Unit, School of Education	Ohio State University
Sister Herman	Chairman, Dept. of Education	Alverno College
John Herrick	Vice-President	Ohio State University
Lester Hunt	Executive Vice-President	Wis. State University Eau Claire
A. T. Lindley	Coordinator, Bureau of Special School Services, Department of Education	Purdue University
Carl Midjaas	Director of Field Studies	Michigan State University
Norbert Nelson	Bureau of Special Services Department of Education	Purdue University
James Potter	Architect	Madison, Wisconsin
Gordon Richardson	Assistant Professor, Iowa Educational Information Center	Iowa University
Donovan Riley	Vice-President for Business Affairs	Wisconsin State University La Crosse
Roger Seager	Chairman, Department of Educational Administration and Supervision	University of Wisconsin Milwaukee

Name	Position	Institution
Merle Sumption	Professor, Department of Educational Administration and Supervision	Illinois University
Charles Trotter	Specialist, School Facilities Planning and Administration	U. S. Department of Health Educational, & Welfare
Howard Wakefield	Director, Cooperative Educational Research and Services	The University of Wisconsin
Russell West	Coordinator of Surveys and Evaluation Bureau of School Surveys	Michigan University
Everett White	Associate Dean, School of Education	Wis. State University Whitewater
Russell Wilson	Consultant, School Plant Planning and Reorganization, Bureau of School Services	Michigan University
A. I. Winther	Dean, School of Education	Wis. State University Whitewater
Arthur Wohlers	Educational Administration Facilities Unit, School of Education	Ohio State University

First Session

Designing the Environment of Educational Enterprises

Consultants for this topic were Sydney H. Williams, who surveyed the state of art in planning, Max E. Anderson, who discussed problems of planning, particularly in education, and Kenton A. Peters, who concluded with the architect's view of school planning.

Williams prefaced his survey with a statement of objectives. Planners should have the improvement of urban society as their broad view, which may then be narrowed by looking for what is good or bad. An acquaintance with the standards used in different fields is critical to this objective. Planners must also master the techniques and ascertain the values relevant to specific areas; e.g., traffic.

The planning process must progress from broad objectives to specific programs in order to maintain the relevance of specific to broad plans. To begin with, goals, not platitudes, must be established; e.g., health and safety. Citizen involvement should be considered at this point. Research and predicition will require new tools such as simulation and regression, new programs such as population and economy, and physical trends in development; e.g., trend surface analysis.

Initially, alternative plans should be developed and special studies instigated when needed. The general plan which is then prepared should include definite factual data and strong recommendations. In this respect urban plans will differ from architectural plans, every part of which is equally probable. Finally, a schedule for realizing the general plan should be drawn up. It must not be forgotten, however, that frequent corrections in plans will be necessitated by the upward spiral of a community.

School planners should turn to school authorities for standards and for reactions to potential sites. Moreover, the master plan should be adopted by the school board. In education, planners do not include detailed capital planning, and they are more concerned with departures, such as the campus plan as opposed to the neighborhood plan for education.

Anderson stated that, although school plant planning and city planning cannot be done effectively without one another, they are now at odds. Failures at present may be found at three levels: the conceptual, administrative, and technical.

At the conceptual level, city planners fail to understand the school in proper terms, its functions and ends, and school planners do not understand the strategic role of schools in the city building process. City and school planners alike fail to see how each affects the other.

School planners tend to overlook environmental factors. The age of structures should not be the primary consideration. It must be recognized instead that the school is a key to revitalizing urban neighborhoods. School locations, for example, can determine property values and prejudice city planning decisions.

City planners neglect proper school functions while school leaders fail to see the school as a potential site for adult cultural meetings, educational and youth centers, family counseling and parenthood preparation, programs for the aged and the handicapped, and so forth. In fact, the allocation of federal grants hinges more and more upon comprehensive local and regional plans, and may, in the future, be tied exclusively to such planning (e.g., the model cities program).

School organization is a problem (e.g., 6-3-3). Flexibility with respect to organization and size is necessary in different parts of urban areas. Converging major arteries, for instance, may alter conditions for typical neighborhood schools. Schools should be a tool, not an object, of development. School considerations need to be integrated with the mainstream of public decision-making, for traffic, school and other planners often duplicate efforts. Moreover, schools should become more involved in community development activities. Zoning features, for example, can, and ought to be considered by school planners.

On the second level, the balkanization of government leads to administrative difficulties. Each local government unit should be assigned enough functions to balance needs and resources and deal effectively with conflicting interests.

Peters stated that the architect infuses his role with "renaissance" scope and quality, yet often feels like a leader who is unsure of the direction of his followers. Individuals may dream of unattainable things, whereas the architect's reality is defined by the limits of bricks, metals, plastics, etc.

Decisions concerning unit costs, quantity and design of space, and programs are usually made by school officials prior to the architect's appearance, thus diminishing his influence. On the other hand, the determination of space for each student function, growing out of the community philosophy, is a critical decision, and yet the decision concerning academic or vocational emphasis, for example, is usually made late if at all. Consequently, the preparation of students is obsolete and must be brought up to date.

Involvement of architects in early stages of the planning process would be a step in this direction. Furthermore, decision makers and consultants need to concentrate on consequences, final products, and performance, rather than furniture, outlets, square footage, etc.

Currently, emphasis is on flexibility as an end product, whereas bilateral lighting was in vogue in the 1940's and carpentry in the 1950's. Flexibility has been subject to criticism in practice rather than in concept. Some methods of achieving flexibility, for instance, can incur substantial increment in cost, hence, experimentation in this area has been justified only when limited to the cost determined by effective use by knowledgeable teachers.

The concept of community and its balanced development has been seriously impaired by school location; i.e., the use which a community can and should make of a school has been restricted. High density urban sites, for example, are detrimental to school-community interaction rather than the reverse.

Decision makers have outmoded concepts of education based on their own experience. They fail to realize that esthetics has a place aside from window dressing. Space, upward and downward, must be recaptured, and functions and uses mixed.

The session concluded with a series of questions and discussions:

(1) Which is more deficient in planning, the local school district or the university?

Williams The Evolution of planning has been slow. The broad pedestrian plaza at Berkeley was not designed as an arena for political activity or protest.

Schumaker Universities are in a better position than school districts to preplan and acquire sites. They have a better idea what their student body will be like ahead of time.

(2) What has been the reaction on attendance units of varying sizes?

Anderson We get blank stares.

Beauchamp Yet it seems that school groups would usually resist.

Fruth Change of environment is the educational pattern of slum area children.

Williams Do school people make firm recommendations concerning social problems? The administrative organization rather than the program seems to be at fault. Long travel is <u>not</u> the answer.

Nelson On the matter of performance specifications, architects are given opportunities, but seldom enough time. The architect may think he is preparing performance specifications, yet his work is obviously earmarked.

Williams The technical problem cannot be solved without a philosophical foundation.

(3) What about the lack of flexibility in grading in connection with schools as tools of development?

Nelson Local conditions should set standards of size and organization. If the school is cast in a reconstructionist role it goes beyond its present mission.

Peters The jurisdictional units are overlapping concentric circles, as are the functional interests; e.g., schools and police protection.

Beauchamp Planners may help us avoid some of the demands made by the rest of society. City planners, for instance, do not recommend open housing, which can result in turmoil that schools are expected to correct.

Wilson Is four or five house a day out of the ghetto really useful? Perhaps we can't afford not to have open space in urban centers. Certainly the homogeneous neighborhood concept is not obsolete. The goal should be social, economic, and services integration of neighborhoods. Subdivision laws and zoning should mix housing by economic levels.

Conrad Planners need more experience working together.

Williams Planning commissions like school boards have been separated from the legislative bodies with a view toward purity, but perhaps that "purity" is no longer essential.

(4) Who needs to be involved in local government planning? Is the concentric ring concept outmoded?

Anderson Planners espouse diversification rather than formulas. Herbert Gans and others have attacked the concept of heterogeneity, however, so it may not be the answer either. Can heterogeneity, for example, be achieved in the face of mobility and real estate forces? The heterogeneity in standards is more to the point.

(5) As a planner, what do you think of the educational park idea?

Anderson The idea is merely one of many solutions. The idea is unsound on the grounds that, at the elementary level, the nearness of the home is still vital. A child cannot be expected to make a quick transition from the parent dominated environment to a huge school setting.

Fruth Of course, administrative convenience should not be the sole desideratum. Elementary and junior high grades should not be separated simply on the grounds that it is not easy to administer them together.

Williams The more information (esp. performance standards information) the planner can be given, the better he can do the job.

Anderson Planners have historically consulted specialists in sanitation, traffic, education, and so forth. Education is still using standards developed in the 1930's and 1940's.

Conrad Standards are, however, being abandoned in favor of guides, or rather, the exercise of professional judgment.

(6) Educational specifications should be written as performance specifications, but how can we see how our performance criteria are being met?

Peters A document which is intelligible to both parties is required. A document which will specify what the child is expected to gain by occupying a space, and which will detail the task requirements, such as tactile tasks; e.g., modeling clay, and sonic and visual tasks.

(7) How would ventilation be controlled?

Peters In the case of sedentary tasks it could be varied with group size, but more experience and information is needed in this area.

Nelson We do give incompatible assignments. The idea is good.

Beauchamp The designer needs to get information from the people concerned. He must establish, for instance, what they intend to do in the room.

Nelson Cavdell took teacher and class out into a field and attempted to circumscribe their tasks.

Beauchamp Perhaps space should be designed for a variety of methods of information dissemination.

(8) How do we learn where people are going?

Williams We do not know this and, yet, we are asked to help with decisions concerning these matters. The time alloted us will determine how closely we can approach that knowledge of direction.

Anderson We lack literature on livable urban environments and conferences cannot really settle the issues. Definition is required before a useful dialogue can get under way.

(9) Is there a distinction between planning for that which is not developed and for that which has decayed?

Williams The sorting of children for education should be a psychological process.

Conrad Some firms, such as (perkins) and Will, are working with (consortia) (of groups).

(10) Can happiness be a function of design? Should we use the large urban setting as our basic problem?

Nelson A relatively small portion is effected by minority problems. Mumford cannot solve these problems in congressional hearings.

Anderson The spirit seems to be to abandon and build anew. We do have the tools for corrections.

Williams We can design and build entire cities. The primary problem is funding. The decent housing idea of the 1930's may be a solution to social problems.

Peters We must continue to work together, and study the problem.

Second Session

Capabilities and Promise of Data Processing in Comprehending the Educational Environment

Dr. Charles Trotter is a specialist in the United States Office of Education's Office of Construction Service. Dr. E. Gordon Richardson is a staff member at the Iowa Educational Information Center.

Trotter prefaced the topic by briefly describing some new developments in the Office of Construction Service of the United States Office of Education. The Office of Construction Service, which is concerned with all levels of education, employs 250 persons, 39 of which are in the Division of Facilities Development. The personnel includes Assistant Commissioner Milecrane, Robert Miller of the Division of Construction Support, John Cameron of the Division of Facilities Development, William Chase of the Design and Materials Branch, Charles Trotter in the Design Section and Ralph Finchum in the Plant Management Section. Chart 1 provides a breakdown of the departmental hierarchy.

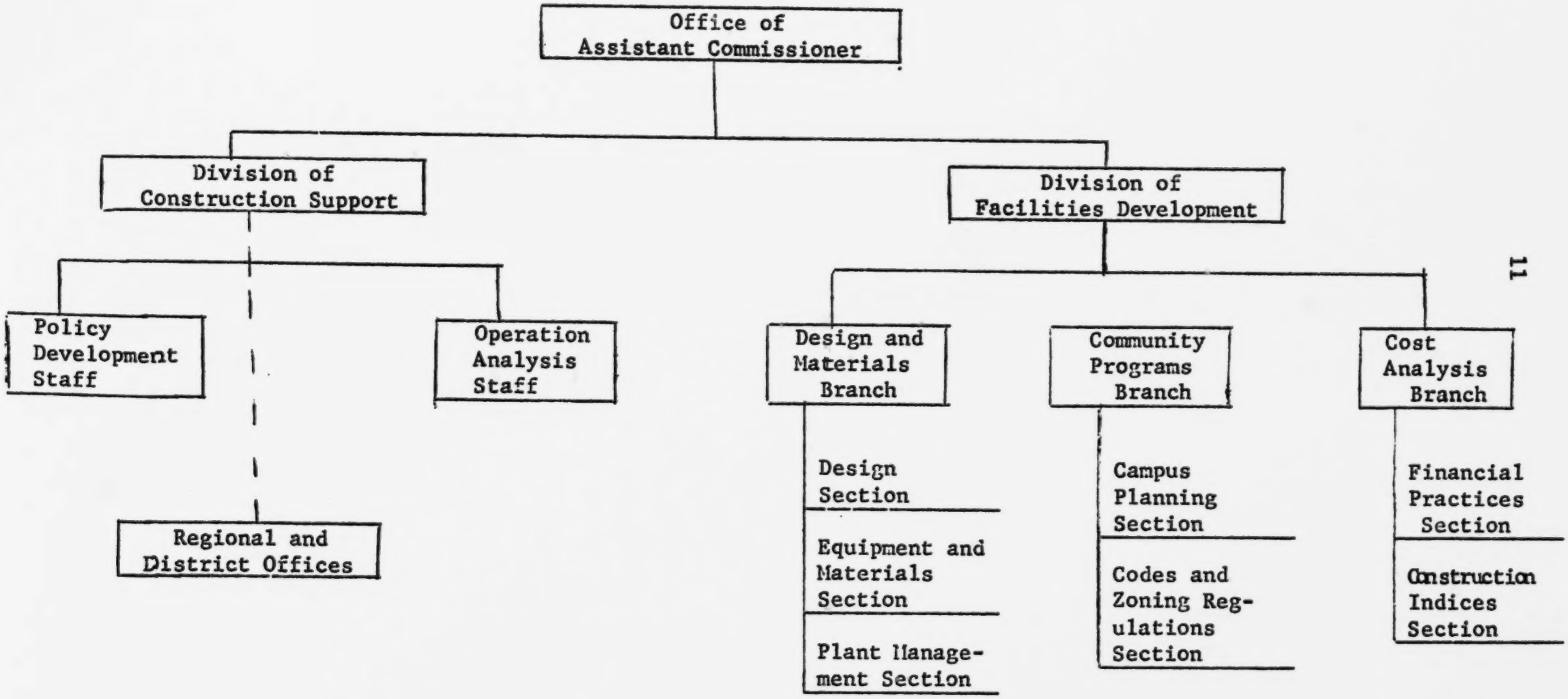
Richardson stated that the Iowa Educational Information Center (I.E.I.C.) resulted from the combined efforts of the University of Iowa and the Data Processing Institute. Howard Jones, Dean of the School of Education, and E. F. Lindquist, Director of the Measurement Research Center, serve on the Center's Board of Directors along with the State Superintendent of Public Instruction.

The Center now uses computers for (1) recording operations data, such as payrolls and records; (2) decision-making, i.e., mustering information to be used in connection with a problem; and (3) research, or, more specifically, the generalization of a problem. Although computers have not been used until recently, data processing itself is not a new development.

The Iowa Educational Information Center is now using the Cardpac system which is mandatory in the state schools, though regarded with disfavor by some educators. All of Iowa will be on a DP property accounting system by 1970. The Cardpac system grew out of a need for largescale longitudinal information on (1) pupils, (2) personnel, (3) programs - e.g., curricula, (4) facilities, and (5) finance. Community information, and other kinds of information, may also be needed. The system is now operational for the first three categories on a fast retrieval program called Project-2. Information for category (1), pupils, includes test, schedule, marking and attendance data for 600,000 pupils in 2000 schools. Certification, schedule or assignment, and class load data rea required under category (2), personnel. Information on courses and sections is processed under category (3), programs. The remaining two categories, facilities and finance, are still in the developmental stage. Data items for facilities will be similar to those listed in the United States Office of Education Handbook #3. Finance information will include payroll system data, but other data sources have not yet been determined.

Chart 1

OFFICE OF CONSTRUCTION SERVICE



The Cardpac system does have some problems. Occasionally the cards for pupils are out of sequence. The reorganization of school districts can also cause difficulties. Two students in the same district for instance, may end up with the same number. Curriculum reorganization and data retrieval from magnetic tape can both cause problems.

The Iowa Educational Information Center's Cardpac system can contribute to educational planning in a number of ways.

In the first place, for a cost of only $3.25, the system can yield ten-year enrollment projections based on the mean survival by grade for the previous ten years. For a sample projection, see chart 2.

Moreover, the Cardpac system now provides the most accurate census data available in Iowa. Census data from this system, which is in demand by police and fire departments, urban renewal people, etc. is required in Iowa every two years and costs only 8 cents per card to collect. The Cardpac system cards are kept up to date on a daily basis, and almost daily contact is maintained with utility companies, while some contact is maintained with builders and planners.

Finally, for the Facility Utilization Analysis Program, the Cardpac system can provide analyses of facility utilization by teaching or pupil station, by type of facility, etc., based on standards and actual use.

Concerning data transmission: area vocational schools are taking over the load of computer processing or analysis, and in particular the processing for the operational categories, since, with terminal cables, printers can be fed by I.E.I.C. computers; e.g., the preparation of warrants. Also, attendance reporting is now being done with stencil cards.

In connection with optical scanners: although the Michigan group has returned to the key punch system because of inaccuracies, the Iowa scanner is reputed to be very accurate at high speeds.

Scheduling costs for the Computer Scheduling Service of the I.E.I.C. include a consultant fee of $300 for the first school in a district and $200 for each additional school in that district. The per-pupil charge for basic services is $1.25. The complete costs and services are given in the Computer Scheduling Service's brochure and service request form, "Update - Computer Scheduling Service".

Chart 2

COUNTY ENROLLMENTS..., 7 YEARS OF HISTORY AND 10 YEAR OF PROJECTIONS

SCHOOL YEAR	GRADES K	1	2	3	4	5	6	7	8	9	10	11	12
60 - 61	788	696	745	727	669	640	671	666	722	531	467	467	511
61 - 62	737	782	688	722	603	663	621	687	634	729	494	432	436
62 - 63	738	737	765	661	708	672	655	629	676	690	680	496	410
63 - 64	735	774	725	749	656	720	671	668	632	691	639	655	477
64 - 65	695	764	748	725	720	677	724	692	673	652	682	651	613
65 - 66	731	721	712	732	707	694	647	721	671	691	620	659	615
66 - 67	744	750	688	704	713	697	673	658	695	664	629	560	598
67 - 68	737	761	725	673	686	706	683	684	645	714	623	606	525
68 - 69	730	754	736	710	656	679	692	694	670	663	670	600	568
69 - 70	723	747	729	720	692	650	666	703	680	688	622	645	563
70 - 71	716	740	722	713	702	685	637	677	689	699	646	599	605
71 - 72	709	733	715	707	695	695	672	647	663	708	656	622	562
72 - 73	702	726	708	700	689	688	681	683	634	681	665	632	583
73 - 74	695	718	702	693	682	682	675	692	669	651	639	640	593
74 - 75	688	711	694	687	675	675	669	686	678	687	611	615	600
75 - 76	682	704	687	679	669	668	662	680	672	697	645	588	577
76 - 77	676	698	680	672	662	662	655	673	666	690	654	621	551

Third Session

Optimum Learning Environments - Design Mechanisms, Principles, and Applications

Consultants for this topic were Professor Byron C. Bloomfield, Director, Environmental Design Center, who outlined its origin and purpose and Dr. Darell Boyd Harmon, Research Professor in the Environmental Design Center, who discussed the physical problems of educational environments and suggested improvements.

The Environmental Design Center, (EDC), was established after a two-year period of study by faculty committees representing ten academic disciplines. The need for environmental design research and instruction leading to the degree of Master of Science was based on the premise that man is the most important element of society; that research findings have identified relationships between physical surroundings and human performance; that physiological health and psychological well-being are affected by environmental variables; and that social behavior is influenced by enabling elements of physical environment. Bloomfield explained that the program for EDC grew out of a conversation with Eugene Higgins (USOE) and his mention of Darell Boyd Harmon in conjunction with fifteen medical disciplines, studied the epidemiology of 160,000 school children in Texas and made follow-up studies in Winter Haven, Florida. These studies have since been accepted as valid and viable by design specialists.

EDC, which is less than two years old, is still defining problems and formulating principles. At present, there is much substantive information, but virtually no task information about subjects or curricula. It is hoped that the Center can use systematic methodology in the identification and investigation of educational tasks.

Harmon, who has recently completed a study he made with clinicians of the primary causes of visual problems, explained that over 70% of these problems have been created by working environments, especially the classroom. Approximately 75% of the body mechanics problems afflicting 30% to 40% of the population, problems that do not become severe until age 40 and over (e.g., those of the lower back and neck), originated in the school environment. Over 50% of children's nutritional problems stem, not from improper food, but from the over-demand on energy output imposed by the conditions of "occupational" environments. Cardiac problems and others are also linked with these environmental conditions.

Adults have become conditioned to see through and hear through their physiological limitations and they continue, unnoticed, to violate many principles of physiologic action.

Studies on color displacement have shown that:
(1) The color spectrum distribution on the retina necessitates a balanced white (from the white light spectrum) on the work surface.
(2) Color displacement affects our depth perception and focus.
(3) Variations in the brightness of colors in the spectrum require some equilization.
(4) At six meters, a blue wall will move away and a red wall will move closer to the viewer. These are accommodative and not psychological adjustments.

(5) Objects placed in front of the red and blue walls respectively are comparably increased and reduced in size.
(6) One or more diopters must be added to focus the blue and reverse the red.
(7) Although an adult, working with fewer clues, can adjust to color displacement conditions, a child's perceptions can be blurred by color surrounds.

Work done with brightness contrast indicates that:
(1) Bright areas tend to advance, dark areas to recede. Hence white chalk on a black board moves away from the surface when viewed from a distance of six meters, and over-accommodation would be required to maintain resolution. Twelve numbers on a board, for example, require six fixations, four of which depend on space displacement.
(2) Dark on light or light on dark space displacement is a critical optical requirement, especially when the material is new. It demands concentration or requires observation from different distances.
(3) Many visual defects result from discontinuity in contrast; i.e., moving from one contrast to another; e.g., dark to light. As many as 25% of high altitude jet pilots, who must look from a high contrast empty sky to the control panel and back again, become nearsighted within twelve months.

The minimum working distance for visual tasks is the distance from elbow to knuckles. Even a 10% reduction of this distance will hamper eye-hand coordinations, induce myopia and interfere with resolution in surroundings. Moreover, more freedom of movement is possible on a surface inclined at 20°.

A general discussion followed Harmon's remarks:

Richardson: How can the conflicts between physiological and psychological forces be resolved?

Harmon: Too many cultural definitions of color, and too much pressure for novelty, tend to limit, or create harmful environments. Mourning colors, regal colors and purple, or the use of colors from both ends of the spectrum, are detrimental, for resolution moves back and forth, and the resulting oscillation induces awe.

Potter: This room is green,how about it?

Harmon: It is all right for discussion or activity. A warm gray, or something on the warm side with high reflectance would be better for sustained close work. The question is, is the environment designed to attract attention or as a work area.

Conrad: As contrast is reduced, how about the energy required to see the task?

Harmon: Colors can be used as an energy source for seeing tasks. Yellow, not white, on green of a specified type is effective. Relative luminosity is as effective as contrast, and more effective than absolute contrast, for luminosity reduces the washing effect of the after-image of the background which overlaps the figure.

Midjaas: How do types of lighting differ in adequacy?

Harmon: For sustained near tasks, the ideal color temperature of an illuminant is 2850° Kelvin. Fine color differences are most readily identified at this temperature. Since flourescent light is a discontinuous spectrum, the desired temperature can only be achieved with incandescent light. A combination of sources, flourescent and incandescent is the answer. Warm white flourescent and some daylight is the best combination.

Sumption: Are there racial differences? One university campus has five buildings of Japanese design in black and dark red.

Harmon: Essentially not. There is very little difference in the color temperature of the skin among races although there is a reflectance difference. There may also be dietary and sociological differences. In Mexico, for example, the calcium balance effects the parathyroid functions which in turn limit the capacity to see color to wide bands of pure color like green, red and yellow. When Texas school children were injected with organic calcium, their capacity to produce primitive Mexican art was disrupted.

Potter: What about the standards of the Illuminating Engineering Society?

Harmon: I am not happy with school lighting based on a visibility standard geared to the recognition of minutae, for this inhibits the recognition of the contours of words and phrases. Meaningful recognition occurs at lower levels such as 37 foot-lamberts for a two-dimensional task. Achievement within 95% of the student's ability is possible with a 55 foot-candle incident to the task.

Miles Tinker of the University of Minnesota psychiatric staff developed the following curve of acuity which yielded the 37 foot-lambert standard:

Acuity (A) = Constant (K) x Intensity (I)

This development has been confirmed in England by Hopkins who discovered the 95% performance measure.

Large area light sources, which give hemispheric rather than spherical concentration of light, are better than troffer lighting. Sources which yield a spherical concentration of light require hard surfaced furniture to produce enough light reflection from the ceiling to do a large area job.

Wilson: What about air-conditioned buildings, reduction in Windows, tinted glass and so forth?

Harmon: Individual rather than wholistic design produces these regressions. Climate can be controlled better in a blackout building. The design of color and lighting, however, has become much more critical, for visual problems increase detectable eye damage.

Wilson: Concerning light source combinations: would vapor lamps have spectrum balance in the absence of daylight?

Harmon: Adequate vapor lamps cannot be constructed yet. Incandescent light or some daylight is necessary to level out the spectrum. A combination source which gives 37 foot-lamberts at the work surface is necessary. Ten to twenty-five percent of this should be from a natural source. A flourescent-incandescent combination would require 3,000 to 5,000 watts of incandescent light. Chalkboard lighting is harmful when light chalk is used on a dark background.

Wilson: What about back light, black light, and so forth?

Harmon: The oscillation would be too great for good input.

Bloomfield: Visual adaptation going from dark to light requires only a short time, whereas adaptation going from light to dark requires from 20 to 30 minutes. Going into an auditorium for audio-visual means, or into subdued lighting entails a considerable loss. The ratio of surrounding brightness to darkness should never exceed 3 to 1. If the field of vision includes windows and chalkboard, high brightness contrasts can be reduced with overhang roofs, wing walls, and landscaping. Clear lighting above the board darkens the work surface.

Harmon: Here is some radiant loss data: A classroom with 72° temperature and a large glass area suffers a radiant loss of 59° in winter. Consequently, every youngster exposed to that glass becomes hyperactive in order to raise body temperature. Female teachers over 40 require added temperature, something like 1° per year.

Here are some data concerning hearing loss: If a teacher is off-center in front of a hard surface like a chalkboard, children on the opposite side of the room receive sonic clues at different times, and may consequently suffer hearing impairment. Adequate communication of sound, including the hearing of detail, requires a background of 30 decibels of white sound. Sound absorbing acoustical design is inadequate; what is needed is sound diffusing design. Carpetry, depending on the floor and the selective absorptive qualities of the carpet, can pose problems. A carpet may, for example, distort musical reproduction.

Sumption: Papers and books are black on white. Is that good?

Harmon: Light india or cream is the best paper color. Black on white requires more diopters to focus. Yellow is the most fatiguing. Blue is next. Blackwell, et.al., have conducted visual accuracy tests to substantiate this.

Wilson: What is the effect of visual tasks on calorie expenditure?

Harmon: The environment can produce a sharp rise in calorie expenditure which may double the error rate.

Midjaas: How should one study the classroom as an environment?

Harmon: Measurements of biochemical change and electro-physiological muscle action during task performance should be used to determine the minimum action to maximum output ratio.

Bloomfield: The following are Harmon's seven task categories:
(1) Near-range two-dimensional visual tasks.
(2) Near-range three-dimensional visual tasks.
(3) Intermediate-range two-dimensional visual tasks.
(4) Intermediate-range three-dimensional visual tasks.
(5) Far-range two-dimensional visual tasks.
(6) Far-range three-dimensional visual tasks.
(7) Large muscle activity.

Harmon: The relevance of posture to visual tasks grows out of tensions induced by distortions like sitting too straight and slouching too much.

Equipment styling has been a problem for us. Equipment styled for other purposes which is not suitable for work has nevertheless been adopted by school equipment designers. One epidemic of styling is the scoop shovel seat which was designed originally by Houghton during the Chicago World's Fair era for the purpose of minimizing jolting accidents in aircraft. This seat is a curve compounded of three curves. the ideal seat is a swivel seat which allows equal thrust in three dimensions.

Bennett's research on seating design (Brunswick furniture) and the measurements of Taylor's research are still available.

The University of Wisconsin
Environmental Design Center

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